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(54) Fan assembly for extracting fumes, in particular for a pellet stove

(57) A fan assembly (1) is described, in particular for pellet stoves, comprising at least one fan (9), preferably made of an aluminium alloy, equipped with at least one vane (20) with a curved shape with respect to the rotation axis of the fan (9); two closing plates (11, 15) each equipped with a respective hole (12) inside which a driving shaft (4) of an actuating motor (3) of the fan assembly (1) passes, an insulating gasket element (13) placed inside the plates (11, 15), and a plane disc (14) keyed-in or free of rotating with a reduced clearance around the shaft (4) of the motor (3); an active cooling element of the motor (3) and a tachometric system (5).

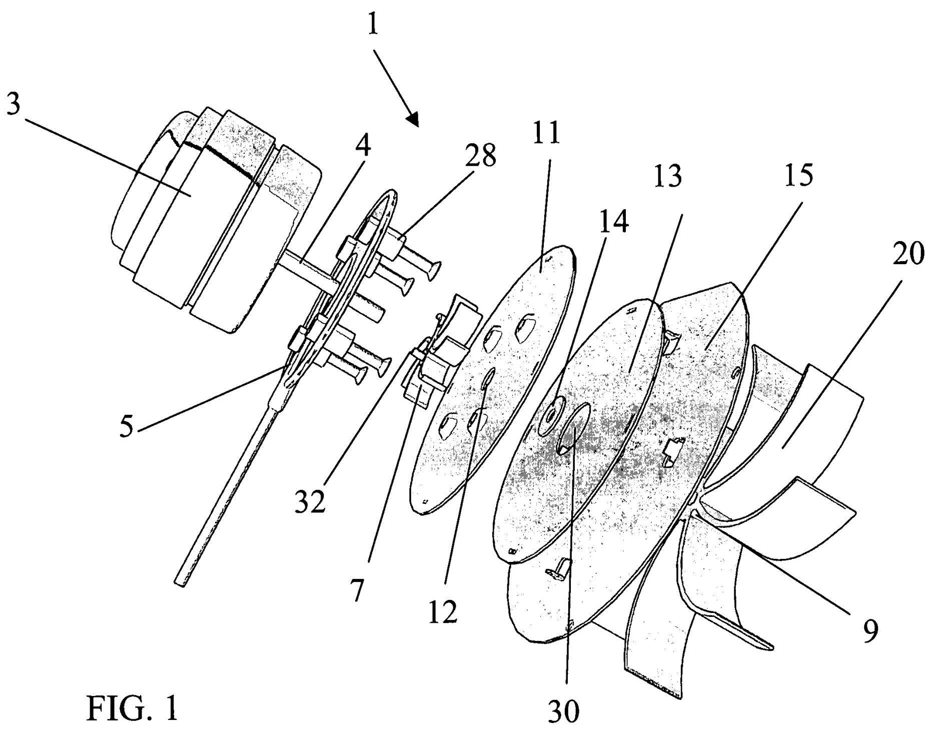


FIG. 1

EP 2 169 236 A1

Description

[0001] The present invention relates to a fan assembly for extracting fumes, in particular a suction device for pellet stoves.

[0002] During these years, a continuous increase of exploitation has occurred for heating energy from different sources with respect to fossil sources. In particular, the use of wood and its derivates has been discovered again.

[0003] In the easiest form for use and automation, wood is transformed into so-called "pellets", to be burnt inside suitable stoves, with burners that control the stoichiometric combustion ratio and guarantee a more uniform gassification of the wooden mass with respect to the one possible with classis pieces of wood.

[0004] For the safe operation of these combustion systems or burners, it is however necessary that the desired air is inserted without pressurising the stove - to avoid fume leakages therefrom - but depressurising it when discharging the fumes, in a similar way to standard stoves, which suck air from the environment due to the vacuum created inside the flue.

[0005] However, natural suction is not enough for this purpose, and moreover it cannot be adjusted. Therefore, a need arises to install a fume sucking device, able to suck gas at a temperature around 300°C in an environment at 100°C.

[0006] Due to safety reasons, moreover, it would be advisable that the sucking device could be able to go on operating for a short period of time even if the current supply is cut off, in order to end consuming the fuel already present in the combustion chamber.

[0007] For the same reason, the seal to fume leakages from the sucking device flange must be as small as possible, and current solutions are not able to pass some of the currently valid regulations for wood stoves.

[0008] Currently-marketed devices are essentially composed of an impeller made of sheared sheet and bent and screwed onto the motor shaft, typically made of stainless steel. Such solution guarantees a high working temperature, but is a penalty for costs (due to the high cost of raw materials and its waste due to unavoidable scraps required by the shearing technique) and for aerial-hydraulic performance, since the geometry that can be made is limited by the production technique.

[0009] Known devices further comprise a double layer of plates, mutually screwed by interposing a layer of thermal insulator, whose purpose is limiting heat radiation to the motor.

[0010] A disc of sheet is further present, which is keyed-in onto the shaft externally with respect to plates and insulator, whose purpose is dissipating heat transmitted by conduction along the shaft.

[0011] Known devices further comprise another flange made of sheet and fastened to the motor, whose purpose is supporting this latter one and some small rubber elements which assemble everything: such small rubber elements, in addition to the supporting function, also perform a thermal shearing and an elastic suspension for vibrations.

[0012] Moreover, in known devices, a two-phase asynchronous motor is also present, with a possible system integrated for generating tachometric signals.

[0013] Sealing to fumnes in the spot where the shaft crosses the insulating containing flange is scarce, since, in order to compensate for axis offsets which are unavoidable when assembling, a wide clearance has been left (3-4 mm).

[0014] In order to allow operation without mains, sucking devices have been marketed equipped with direct current (DC) motors, which however are ill-suited to operate at these temperatures, since they are equipped with internal electronics and permanent magnets. In fact, following experiments performed by the Applicant, such motors, if subjected to the most unfavourable conditions, very frequently fail. A proof thereof is the fact that, in spite of their usefulness, they are not gaining market shares. WO-A-00/57064, US-A-2005/103339 and US-B1-6232696 disclose a fan assembly according to the preamble of Claim 1.

[0015] Object of the invention is solving the above prior art problems by providing a fan assembly for extracting fumes that can be easily and efficiently made, has a reduced cost and is capable of operating at high temperatures. The improvements made by the fan assembly of the present invention will be described in detail below and will be integrated by results of tests performed by the Applicant of the present invention.

[0016] The above and other objects and advantages of the invention, as will result from the following description, are obtained with a fan assembly for extracting fumes as claimed in claim 1. Preferred embodiments and non-trivial variations of the present invention are the subject matter of the dependent claims.

[0017] The present invention will be better described by some preferred embodiments thereof, provided as a non-limiting example, with reference to the enclosed drawings in which:

- Figure 1 is an exploded perspective view of a preferred embodiment of the fan assembly of the present invention;
- Figure 2 is a perspective view of some embodiments of the fan of the fan assembly of the invention;
- Figure 3 is a perspective view of an embodiment of the small fan-tachometric system assembly used on the fan assembly of the invention;
- Figure 4 is a perspective view of a first embodiment of the closing plates of the fan assembly of the invention;
- Figure 4A is a perspective view of a second embodiment of the closing plates of the fan assembly of the invention; and
- Figures 5 to 12 are graphs which show the results of tests performed by the Applicant on known fan assemblies

and on the inventive one.

[0018] With reference to the enclosed Figures, an embodiment of the fan assembly for extracting fumes according to the present invention will now be described. It will be immediately obvious that numerous variations and modifications (for example related to shape, sizes, arrangements and parts with equivalent functionality) can be made to what is described, without departing from the scope of the invention as appears from the enclosed claims.

[0019] The fan assembly 1 for extracting fumes of the present invention is adapted to be used in particular as sucking device for pellet stoves, but obviously it could be employed in any application in which substances have to be extracted from an environment.

[0020] The fan assembly 1 first of all comprises a fan 9 with a special shape. In fact, the fan of the current art (not shown) is made of a sheared and bent sheet of stainless steel, in order to make suitable vanes (not shown). Such vanes are simple rectilinear 90° elements: such shape has the only advantage of being simple to make, but is a penalty both for flow-rate and for turbulence of the transferred gas. In order to solve this, it is necessary to work at a higher speed with the same fan flow-rate and head, thereby creating more noises with this product.

[0021] Moreover, the impeller size is fixed, since it is dictated by the die that forms it, and therefore does not allow adaptations depending on different applications (for example different stove models, application inside ventilated kitchen ovens, or other situations in which it is necessary to move gas at a high temperature).

[0022] Moreover, the use of stainless steel is a redundant engineering choice, since its maximum working temperature is at least 600 °C greater than the required one. The result is that its cost is excessive with respect to the result.

[0023] The inventive fan 9, instead, is made of an aluminium alloy, material which is cheaper and capable of being hot-formed by extrusion at low costs. Its maximum working temperature is scarcely higher that the actual temperature, but is enough to guarantee its reliability.

[0024] Moreover, the extrusion technique allows making the impeller directly from a bar several meters long, and afterwards cutting it at the most suitable height, in order to suit the impeller to its different applications (as can be well seen in Fig. 2 where three different types of fan 9, 16 and 18 are shown).

[0025] The highest forming freedom possible, moreover, allows making curved vanes 20, and the structure symmetry allows assembling the impeller in its two versions with "forward vane" and "reverse vane", which allows exploring two different ranges of characteristics with the same object.

[0026] In the embodiment shown, the product has been made so that, in its configuration with "reverse vane", it has the same performance of the currently marketed product, in order to allow its immediate replacement, while in the "forward vane" assembling, performances are higher, allowing to increase performances or reduce the number of revolutions with the same vanes, with a consequent noise reduction.

[0027] The inventive fan assembly 1 further comprises at least two closing plates 11, 15 each one equipped with a respective hole 12 inside which the driving shaft 4 of the actuating motor 3 of the fan assembly 1 passes.

[0028] So far, all products of this type have had the plates composing the closing flange of the scrolls configured in a similar way, namely:

- a first internal plate whose sizes are greater than the impeller sizes, suitable to close the scroll opening in which the impeller itself must be installed;
- a layer of insulating material, which protects the motor placed inside the suction area; and
- a second, smaller layer of sheet, whose function is protecting the insulating layer and in this case supporting the motor.

[0029] With this configuration, howver, it is necessary to leave the central hole which allows the passage of the shaft 4 with a great clearance, since an assembling of this type does not allow great coaxialities. Such clearance is of some millimeters, and leakages caused thereby in the fume-sealing system are in some cases greater than those allowed for wood stoves. Such data change according to laws in force country by country, but the trend of the regulations is progressively approaching the most restrictive laws due to safety reasons.

[0030] In the inventive fan assembly 1, instead, an automatically centered sealing system has been inserted, free from gaskets - that cannot be used at such temperatures - that can be made in two different ways:

a) labyrinth-shaped: the solution is based on inserting (keying-in) on the shaft 4 a plane disc 14 thinner than the gasket 13 placed between the plates 11, 15, but with a diameter much greater than the diameter of the hole 12. The two plates 11, 15, placed on the two sides of the ring 14, do not touch it and compel the fumes to travel along a longer and more twisted escape way with respect to the previous situation. In order to realise the necessary axial clearance, a slight drawing on one of the two plates is enough. If this operation is performed when shearing the disc, it does not imply additional industrial costs.

b) with reduced clearance: in this case, the plane disc 14 has the same thickness of the plates 11, 15, but the hole 12 in which the shaft 4 passes is made bigger than itself by a few centimillimeters. When assembling, the ring 14

has the chance of being freely placed with the hole 12 in the rotation axis, since it is not strongly constrained by the pressure of the plates 11, 15.
However, the very small clearance creates a fume seal that, at the working pressures of a combustion chamber, makes leakages in practice undetectable.

[0031] In both above solutions, the insulating gasket 13 present between the plates 11, 15 has been modified, by making therein an hole 30 which has been increased by the necessary amount to house the disc 14, plus an enough clearance to accomodate the maximum assembling eccentricity of the motor 3.
[0032] Finally, the fan assembly 1 of the present invention comprises a solution that allows the active cooling of the motor 3 and provides a tachometric system 5.
[0033] In current fans, in this spot an aluminium disc keyed-in to the motor is simply inserted, whose function is dissipating part of the heat that, through the conduction of the shaft 4, arrives to the motor 3.
[0034] In the inventive fan assembly 1, a small secondary fan 7 has been inserted, which, in addition to providing this service, creates a flow of fresh air, sucked through the opening of the spacer 28 made of plastic material, that passes by the motor 3 in its area aimed to be cooled.
[0035] A tachometric system 5 for detecting the speed of the motor 3 is integrated partly in the small fan 7 and partly in the motor support 3; the system 5 is composed as follows:

a) a magnet 32 of the AlNiCo type or anyway of a type equipped with a sufficiently high Curie point as to guarantee keeping the field at ambient temperature with peaks of 100-150 °C inserted in a suitable hole on a vane 20 of the small fan 7, that operates as exciting device; and
b) a Hall-effect transistor (not shown) co-stamped in the plastics of the spacer 28, that, upon every passage of the magnet 32 near it, creates an electric pulse whose frequency is proportional to speed.

[0036] In the current art, tachometric systems are integrated in the motor. The increase of costs is higher than the inventive solution, since, being the interior of the motor 3 perturbed by strong magnetic fields, it is necessary to use a rare-earth magnet of the Samarium Cobalt type, in order to have an enough signal-to-noise ratio. Such magnets have a Curie point - temperature at which a magnet loses its magnetic characteristics - of about 240°C, sufficient for this application, but they are very costly.
[0037] Cheaper rare-earth magnets (of the Neodimium Iron Boron type) cannot be applied in this case due to their low Curie point.
[0038] In the present invention, instead, it is possible to use a magnet 32 with weaker magnetic characteristics, but with an exceptionally high Curie point (600°C), which further has the advantage of being much cheaper.
[0039] According to a further preferred variation of the present invention, shown in detail in Fig. 4A, the fan assembly 1 always comprises at least two closing plates 11, 15, mutually parallel and concentric, and each equipped with a respective hole 12 inside which a driving shaft 4 of an actuating motor 3 of the fan assembly 1 passes, at least one insulating gasket element 13 placed inside the closing plates 11, 15, and at least one plane disc 14 keyed-in around the shaft 4 of the motor 3; differently from the previous fan assembly 1, however, at least one of the closing plates 11, 15, next to its own central hole 12, is shaped (in 17) in order to go away from the other of the closing plates 11, 15 obtaining a chamber 90 in which the plane disc 14 rotates and in which fumes are compelled to travel along a twisted escape way for cooling them.
[0040] It is finally possible, starting from the solution in Fig. 4A, to shape both closing plates 11, 15, next to their central hole 12, so that they are mutually directed one away from the other, obtaining a chamber 90 in which the plane disc 14 rotates and in which fumes are compelled to travel along a twisted escape way for cooling them.
[0041] With the thereby made fan assembly 1, other advantages are also obtained: it is not necessary any more to depend on the motor supplier (the suppliers capable of making tachometric systems are few); it is possible to provide fans free from the tachometric system for cheaper applications, by simply not assembling the components instead of having to immobilise money in a second supply of motors; it is possible to provide, upon request, fans 9, 16, 18 with more pulses per revolution (for particular applications in which a finer speed adjustment is required) by simply installing a greater number of small magnets on the secondary fan 7.
[0042] Regarding the need of going on venting the stove even in case of lack of current for an adequate time to dispense with the already-present fuel, as already mentioned in the introducting part, the arrangement with direct current motors supplied by a battery is not deemed technically valid.
[0043] The lack of ventilation generates the combustion of the pellets with poor oxigen, because the pellet-type stove is not able to self-ventilating naturally due to the vacuum in the flue, and this unfavourable stechiometric ratio generates the production of carbon monoxide instead of anhydride in combustion residuals.
[0044] The monoxide, in addition to being toxic if it goes out of the stove, is still subjected to combustion - it can be converted into anhydride - and consequently, once having reached the right stechiometric ratio, it can explode.

[0045] Also other producs of wood gassification can be emitted given the lasting heating due to thermal inertia, with the chance of causing similar events.

[0046] In addition, the dangers are increased by the fact that, typically, these stoves are equipped with a ceramic glass that allows viewing the fuel, glass that in these cases is violently projected as chips.

[0047] As known the danger is function both of the potential damage and of the risk that the event occurs. In this case, the damage can have deadly results, therefore the risk must be contained at a maximum. Replacing a very reliable motor - like the asynchronous motor - with a motor able to work with a battery but with lower reliability, could even increase this risk, since this is directly related to the potential number of non-programmed stops. In a household application, the average risk of lack of supply during the operation for periods longer than the one necessary for reaching the dangerous gas concentration, fortunately is low (1/2 events/year); this implies that inserting a motor with a comparable time between failures does not provide any advantage, while a motor with lower time between failures even increases the danger.

[0048] For this reason, it has been chosen to go on adopting an asynchronous motor, with a very high reliability, and provide it with a suitable inverter that is able to make it go on working in case of lack of supply.

[0049] In order to further improve safety and optimise costs, a low-voltage two-phase asynchronous motor has been produced. In this way, it will be possible to directly use the battery voltage without voltage boosters. In addition to reducing the cost, there will also be an increase of reliability (if it is not present, it cannot fail) and intrinsic safety.

[0050] Since this is anyway an asynchronous motor, its operation with mains supply would always remain possible, simply by limiting the supply in its amplitude in case of failure of the inverter, thereby also providing an emergency operation.

[0051] In order to demonstrate efficiency and improvements that can be obtained with the fan assembly 1 of the present invention, herein below the results are included for some tests performed by the Applicant, with the support of graphs in Figures 5 to 12.

[0052] First of all, a comparison has been made of hot air leakages occurring during operation of the hot fumes fans VFC V10 and VFC V11, in which the modification made for reducing the space around the rotation axis in V11 version has reduced leakages from approximately 1 m^3/h to unmeasurable values (lower than 0.2 m^3/h). In the V11 version of the VFC series of fans for extracting hot fumes, the disc 14 has been used that is placed in the hole 30 that houses the shaft 4 connecting fan 9 and motor 3. Measures have been performed with a laboratory-type aerial-hydraulic chamber (SM01). The chamber has been modified for a vacuum use, exchanging the inlets of differential pressure sensors SM01D (which measures the relative pressur upon entering the chamber) and SM01C (which measures the relative pressure upstream of the nozzles). Q(P) has been measured, namely the passage of air depending on the applied pressure difference. Flow-rates have been referred to standard conditions (dry air, density 1.2014 Kg/m3). In the application, the pressure inside the fume-extracting duct, where the impeller is, is higher than the pressure of the room where the stove is. In order to simulate these working conditions, the motor has been vacuum-assembled inside the aerial-hydraulic chamber, with the impeller outside at ambient pressure. The fan model marked with V10 is equipped with a standard gasket, the model V11 is the examined sealing system; in the PA08029 graph, the measure of a stopped V11 has been used as zero, since, as can be seen in the Figure, leakages in such case are null (below the experimental error). The same can be stated for leakages with a moving VAFC V11 (graph in Figure 8). Leakages on V11 axis are minimum and undetectable with our aerial-hydraulic chamber, while for V10, when operating, they are around 1 m^3/h.

[0053] The following tests have then been performed:

1. Measure of the aerial-hydraulic characteristics for the fan assembly of the present invention with respect to a known fan;
2. Measure of electric values in three different flow-rate points (0; 50%; 100%);
3. Check of fouling of the fan assembly of the present invention with respect to a known fan;
4. Check of Hall-effect sensor operation and of max temperatures of motor windings for the fan assembly of the present invention.

[0054] Data that will be shown have been obtained from aerial-hydraulic tests performed on two scrolls:

1. Scroll of the Eco Teck stove;
2. Standard scroll with medimu-low power.

[0055] The technical characteristics of the two scrolls were as follows:

Scroll	Internal ∅ mm]	Inlet ∅ [mm]	Exhaust ∅ [mm]	Exhaust Area [mm^2]	Notes
Eco Teck	185	100	70	1924	Semicircular exhaust section
Standard	185	95	70	3848	

[0056] The technical characteristics of the fan assembly of the present invention were as follows:

Material	Aluminium N-AW6060
Diameter [mm]	151
Thickness [mm]	27
Number of vanes	8

[0057] The known fan operates in reverse vane mode, the fan of the present invention can be installed indifferently in the two operating directions.

[0058] The graphs of the comparison performed with Eco Teckè scroll is included in Figura 9. From this graph, it can be noted that, in the operation with reverse vane, the fan of the present invention has a maximum flow-rate slightly lower than the known fan (93.3m^3/h versus 94.7m^3/h); however, for 2/3 of the characteristic, it is slightly greater; in the configuration at maximum static pressure level, the fan of the present invention clearly prevails (304Pa versus 288Pa). Regarding the operation as forward vanes, the fan of the present invention clearly prevails, reaching a maximum flow-rate of 96.1m^3/h, and such supremacy can be verified constantly in any point of the graph; the maximum static pressure is of note: 318Pa.

[0059] For a better understanding, a graph is included regarding "Flow-rate difference depending on static pressure" (Figure 10). It can be easily noted how the fan of the invention, used as reverse vane, under typical use conditions (P static 150 ö 200 Pa), even if slightly more performing than the known fan, substantially has the same performances of this latter one and can therefore be considered as spare part; however, in the forward vane configuration, performances are clearly higher. It must be noted that, in order to pass from the configuration with reverse vane to the one with forward vane, it is enough to withdraw the fan and assemble it in the other direction, The known fan can work only in a configuration with reverse vane.

[0060] The comparison performed with a standard scroll is included in Figure 11. In this configuration, the known fan reaches maximum values of 268 Pa and 157 m^3/h respectively for static pressure and flow-rate. The fan of the invention, assembled as reverse vane, instead, stops at 260 Pa and 156 m^3/h for maximum static pressure and flow-rate. The fan of the invention, assembled as forward vane, clearly exceeds everyone, reaching 295 Pa of static pressure and 162 m^3/h of flow-rate. In the graph of Figure 12, performances are shown as difference of the products of the invention with respect to known products, displaying the flow-rate difference depending on static pressure. It can be noted that the inventive configuration with reverse vane, in the worst case, exceeds the known product by 3 m^3/h, while the inventive configuration with forward vanes exceeds the known fan by 9 ö 10 m^3/h at the characteristic center and arrives at 24 m^3/h under maximum static pressure conditions (it must be noted that the comparison is limited to a static pressure of 260 Pa since neither the inventive fan with reverse vane nor the known fan arrive at 270 Pa).

[0061] Fouling tests have then been performed, made by installing the fans in an Ecoteck Francesca model pellet stove (7 thermal Kw) using the standard scroll.

[0062] The stove has been operated at a medium-low speed for eight days: power levels (% time) ECO 1 (50%), ON 1 (40%), ON 5 (10%). During the test, approximately 105 Kg of pellets have been consumed.

[0063] At the end of the test, the inventive fan has shown homogeneous deposits, prevailing on the opposite side to the one of the rotation direction. Such deposits are composed of thin powders, with a consistency equal to talc, having a maximum thickness of about 0.3 mm and mainly accumulated in the last interior fourth of the vanes. Such deposits tend to spontaneously foliate. In the first and second fourth of the same side, an irregular layer of powders has been noted, arranged as a "spray" and with an almost irrelevant amount. It must further be pointed out that the side exposed to the rotation direction (the one "impacting against the fumes") has no other than traces of powders.

[0064] Also the kown fan, as pointed out by a previous test, tends to get fouled with slags of the same type regarding quality, thickness and position.

[0065] A test has then been performed for determining the maximum temperature reached by the shaft motor of the hot fume fan of the invention, in the area where the temperature screen is installed, together with the tachometric magnet annexed. The purpose has been verifying the chance of using plastic material for this screen and checking the chance of using a standard Hall-effect sensor. The test has been performed by operating the *ECOTEC* stove in a maximum power situation (ON 5).

[0066] A Al-Ni-Co permanent magnet has been installed, 5.5mm long, in the rotor of the Ecofit motor, planting it into one of the housings provided for balancing; the Honeywell SS443A sensor has been mounted in a bracket in such a way as to keep it at a distance of about 2.5mm from the magnet. The stove control electronics has correctly operated; it follows that the type of sensor, the type of magnet and the adopted installation are compatible with its input stages. In order to measure the max temperature reached by the shaft, two heat-sensitive strips have been placed in the affected area. Simultaneously, the operation upder maximum power has been used, in order to determine, by measuring the hot resistance, the working temperature of motor windings.

[0067] The maximum temperature reached by the shaft has been 143 °C < T_{shaft} < 149°C.

[0068] The maximum temperatures of the windings instead have been:

Winding	Resistance at 20°C [Ω]	Hot resistance [Ω]	T computed [°C]	T thermocouple [°C]
Main	333	472	108	114
Auxiliary	353	449	106	114

[0069] T of air next to the motor ≤ 70°C

[0070] Motor windings have worked at a temperature lower than the maximum allowable one, that, for its insulation class (***F***), is 150°C.

[0071] It was then possible to draw the following conclusions:

1. the inventive fan is practically interchangeable with the known fan, both from the aerial-hydraulic point of view, and from the electronic point of view;
2. in case of need, it is possible to assemble it in a configuration with forward vane, obtaining an excess of 8 to 18 Pa of static pressure;
3. the selected sensor (Hall-effect sensor) and permanent magnet have been demonstrated compatible with standard electronics. For such purpose, they are adapted to be assembled outside the motor, guaranteeing a easier maintenance and the chance of adopting motors from different manufacturers depending on market dynamics;
4. from the mechanical-constructive point of view, the inventive fan can be manufactured by extrusion: in this way, the quickest way to obtain non-standard flow-rates consists in increasing the thickness of the fan;
5. always regarding the customisation for particular applications, it is also possible to remove part of the flank next to the fan center: in this way, with the same height, there will be an increase of flow-rate and pressure.

Claims

1. Fan assembly (1), particularly for pellet-type stoves, comprising at least one fan (9), preferably made of an aluminium alloy, equipped with at least one blade (20) with a curved shape with respect to a rotation axis of the fan (9), the fan assembly (1) further comprising at least two, mutually parallel and concentric closing plates (11, 15), each one equipped with a respective hole (12) inside which a drive shaft (4) of an actuating motor (3) of the fan assembly (1) passes, at least one insulating gasket element (13) placed internally with respect to the closing plates (11, 15), and at least one plane disk (14) keyed around the shaft (4) of the motor (3), **characterised in that** the plane disk (14) has a smaller thickness than the thickness of the gasket element (13) placed between the plates (11, 15), but has a diameter which is much greater that the diameter of the hole (12), said plates (11, 15) being arranged on the two sides of the ring (14) and being shaped in order not to touch the ring (14) and being adapted to compel the fumes to travel in a tortuous escape way for cooling said fumes.

2. Fan assembly (1) according to claim 1, **characterised in that** the plane disk (14) has the same thickness of the plates (11, 15), but the hole (12) in which the shaft (4) passes is increased with respect to the disk (14) by few centimillimetres, said plates (11, 15) being placed on the two sides of the ring (14) and being shaped in order not to touch the ring (14) and being adapted to compel the fumes to travel in a tortuous escape way for cooling said fumes.

3. Fan assembly (1) according to claim 1 or 2,
characterised in that the insulating gasket element (13) is equipped with a hole (30) whose diameter is greater than the diameter of the disk (14) in order to house the disk (14) inside and in order to create a sufficient play to do without the maximum assembling eccentricity of the motor (3).

4. Fan assembly (1) according to claim 1, **characterised in that** it further comprises at least one active cooling element of the motor (3) and at least one tachometric system (5).

5. Fan assembly (1) according to claim 4, **characterised in that** said at least one active cooling element of the motor (3) is composed of at least one secondary small fan (7) adapted to create a flow of cool air, sucked through an opening of a spacer (28), said air being adapted to pass near the motor (3) in its area responsible for cooling, and said at least one tachometric system (5) for detecting the speed of the motor (3) is composed of at least one magnet (32) inserted on a blade (20) of the small fan (7), that operates as exciting member; and at least one Hall-effect transistor co-stamped in the spacer (28),
which, every time the magnet (32) passes near the transistor, is adapted to create an electric pulse with a frequency that is proportional to the motor (3) speed, said magnet (32) being of the AlNiCo type or of a type equipped with a sufficient Curie point to guarantee that the magnetic field is kept at ambient temperature with peaks of 100-150 °C.

6. Fan assembly (1) according to claim 1, **characterised in that** it further comprises at least two, mutually parallel and concentric closing plates (11, 15), each one equipped with a respective hole (12) inside which a drive shaft (4) of an actuating motor (3) of the fan assembly (1) passes, at least one insulating gasket element (13) placed internally with respect to the closing plates (11, 15), and at least one plane disk (14) keyed around the shaft (4) of the motor (3), at least one of said closing plates (11, 15), next to its own central hole (12), being shaped in order to progressively move away from the other one of said closing plates (11, 15) obtaining a chamber in which said plane disk (14) rotates and in which the fumes are compelled to travel in a tortuous escape way for cooling said fumes.

7. Fan assembly (1) according to claim 6, **characterised in that** both said closing plates (11, 15), next to their own central hole (12), are shaped in order to mutually move away, obtaining a chamber in which said plane disk (14) rotates and in which the fumes are compelled to travel in a tortuous escape way for cooling said fumes.

8. Fan assembly (1) according to claim 1, **characterised in that** it further comprises at least one asynchronous motor equipped with at least one inverter adapted to make the fan assembly (1) go on working in case of lack of supply.

9. Fan assembly (1) according to claim 1, **characterised in that** said at least one asynchronous motor is a low-voltage two-phase asynchronous motor.

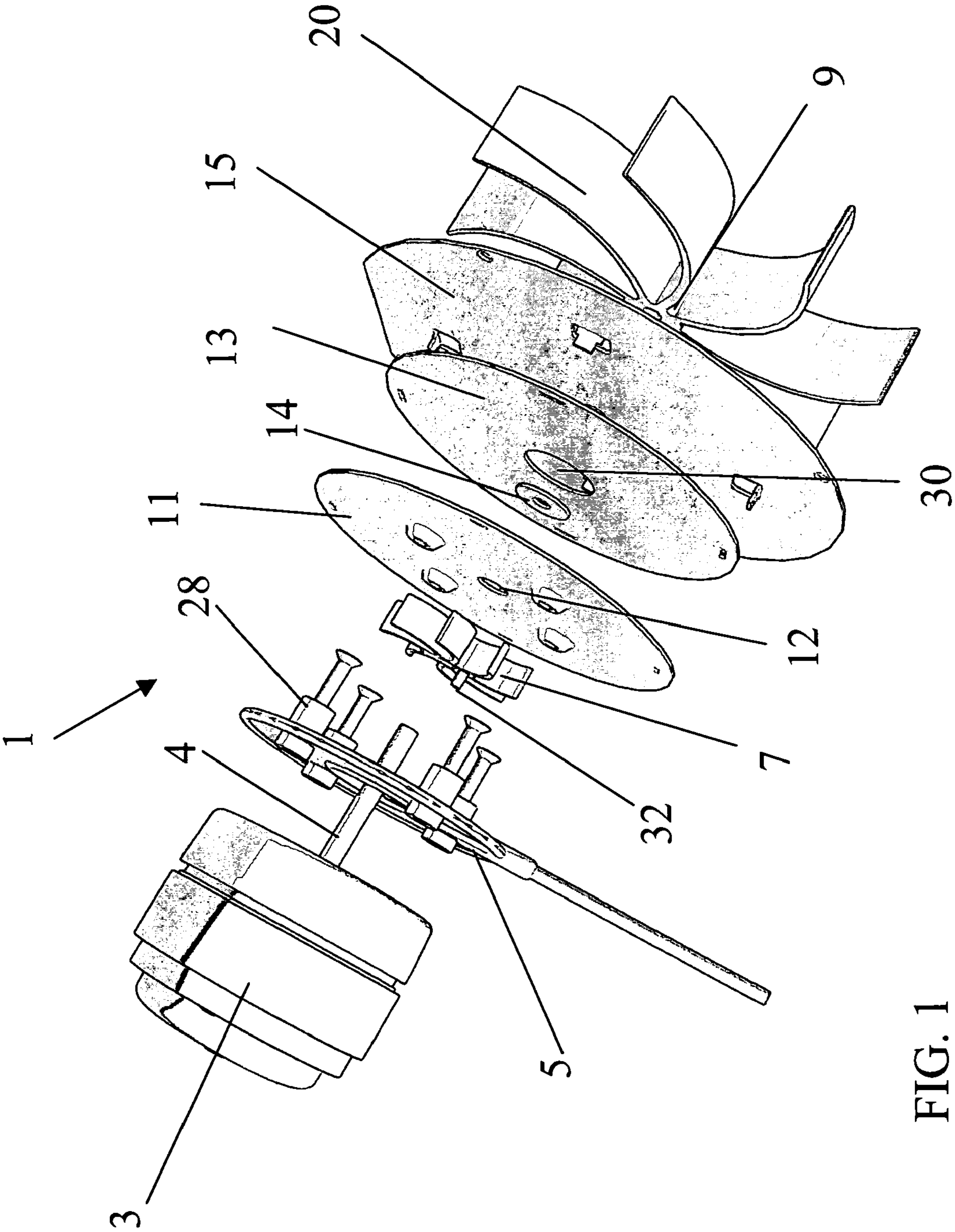


FIG. 1

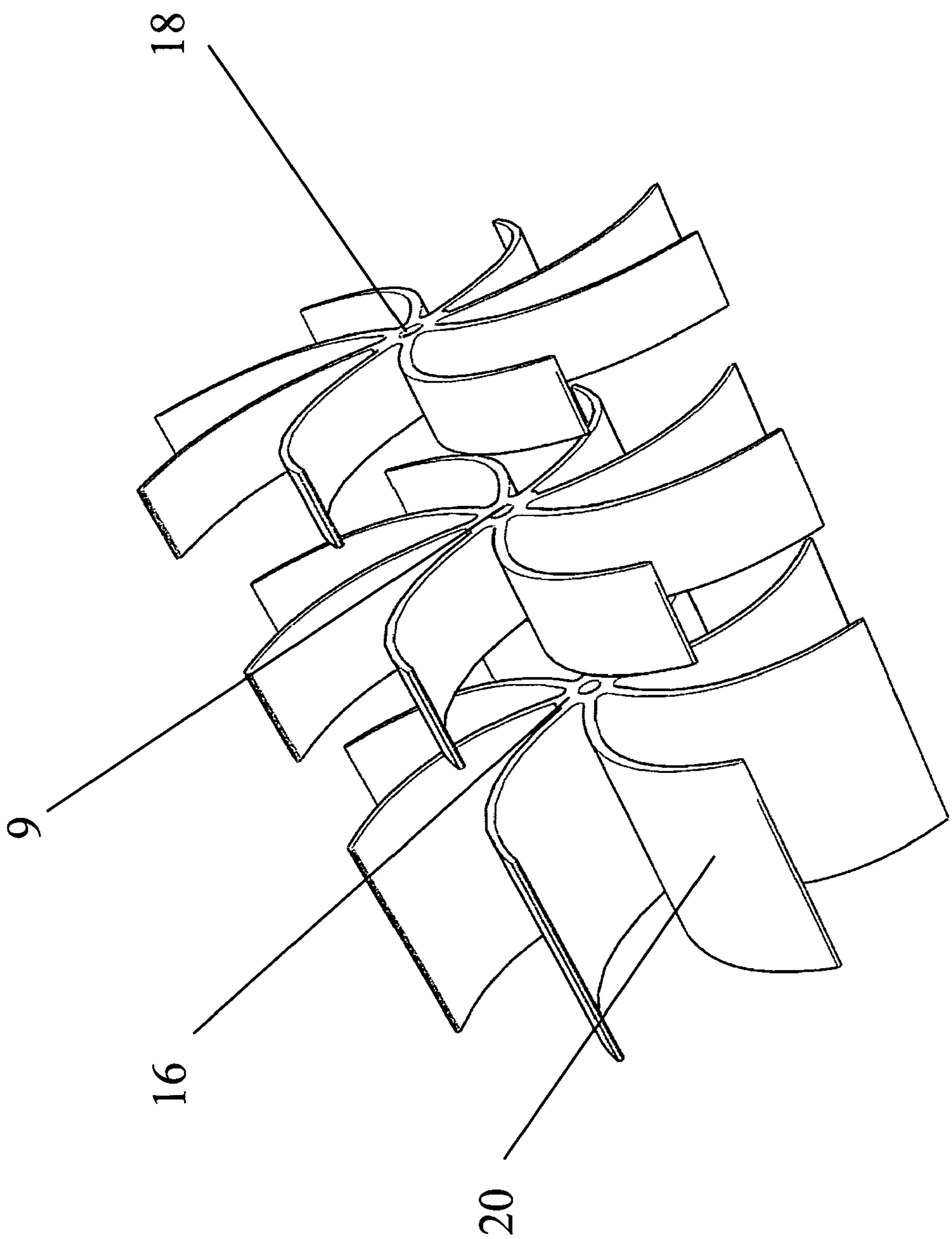


FIG. 2

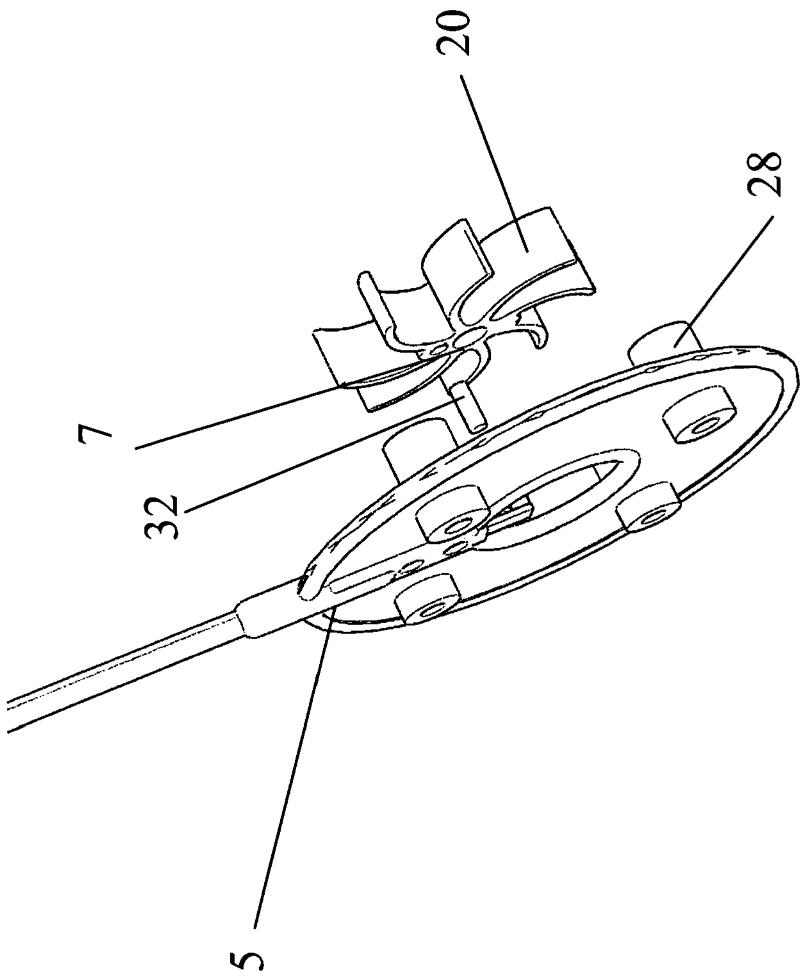


FIG. 3

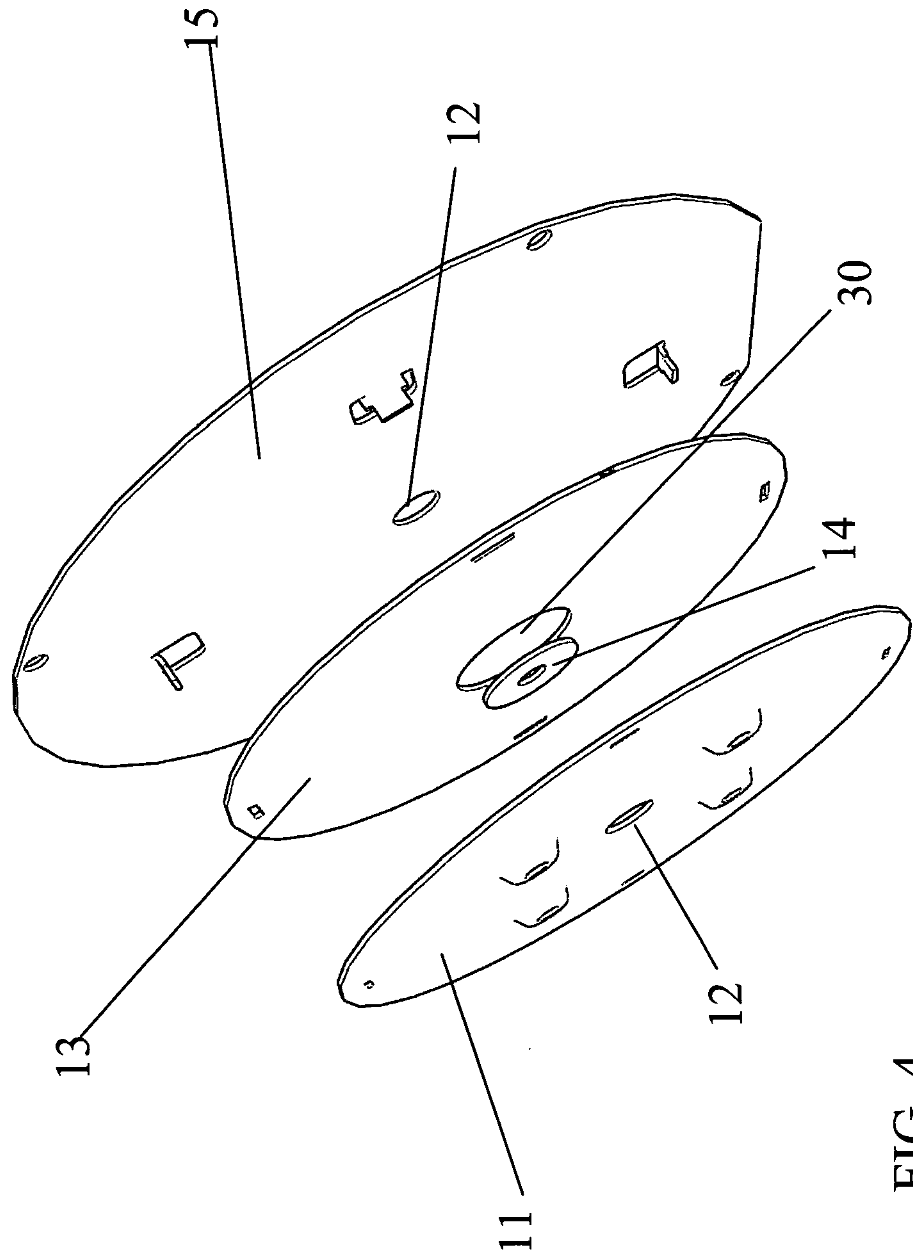


FIG. 4

PA08028

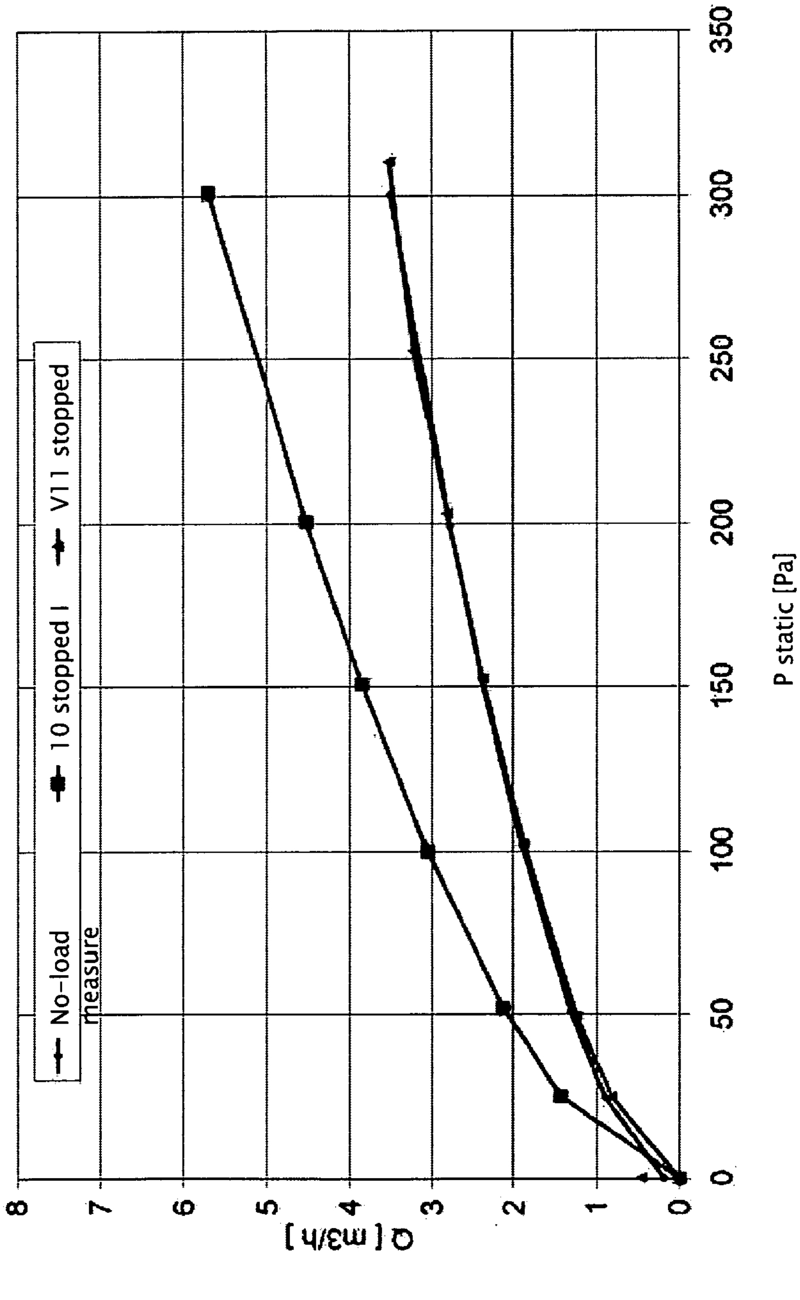
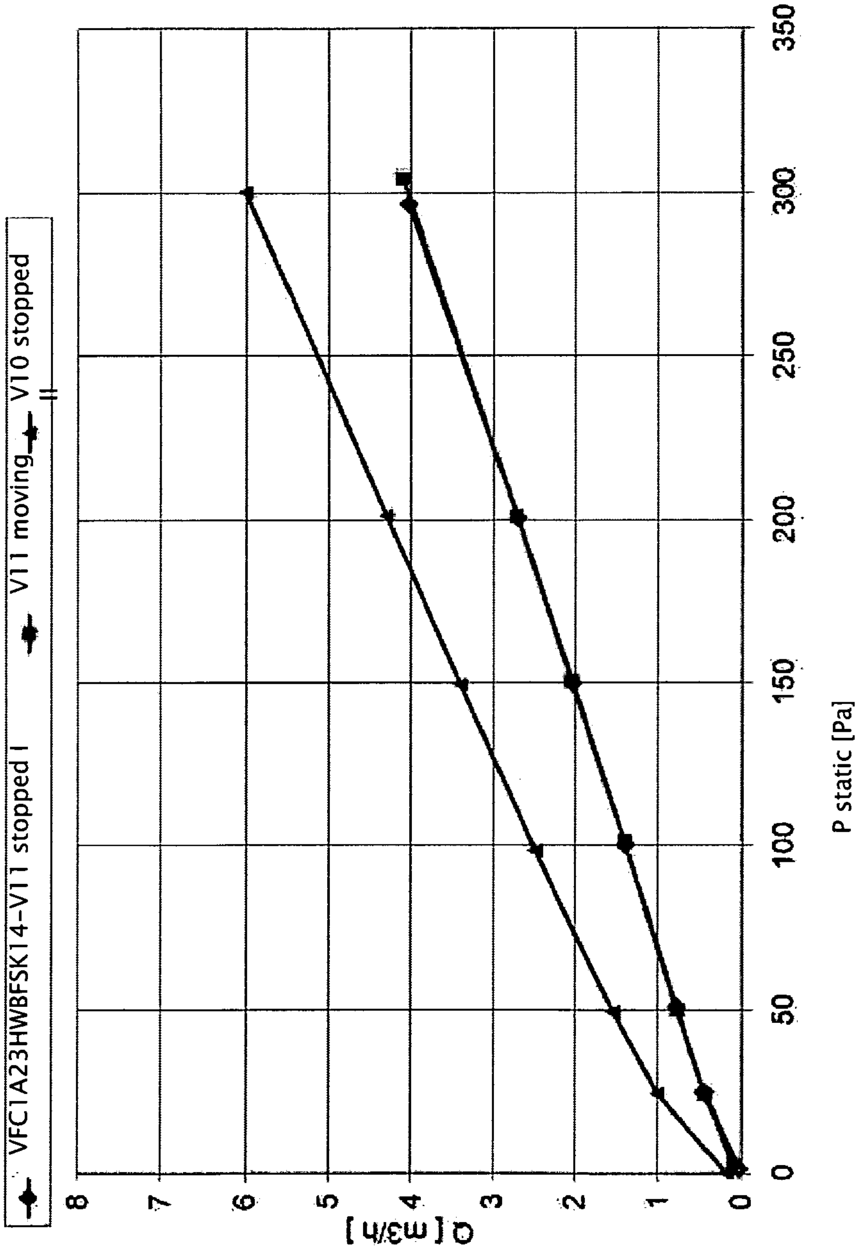


FIG. 5

FIG. 6

PA08029



PA08029

FIG. 7

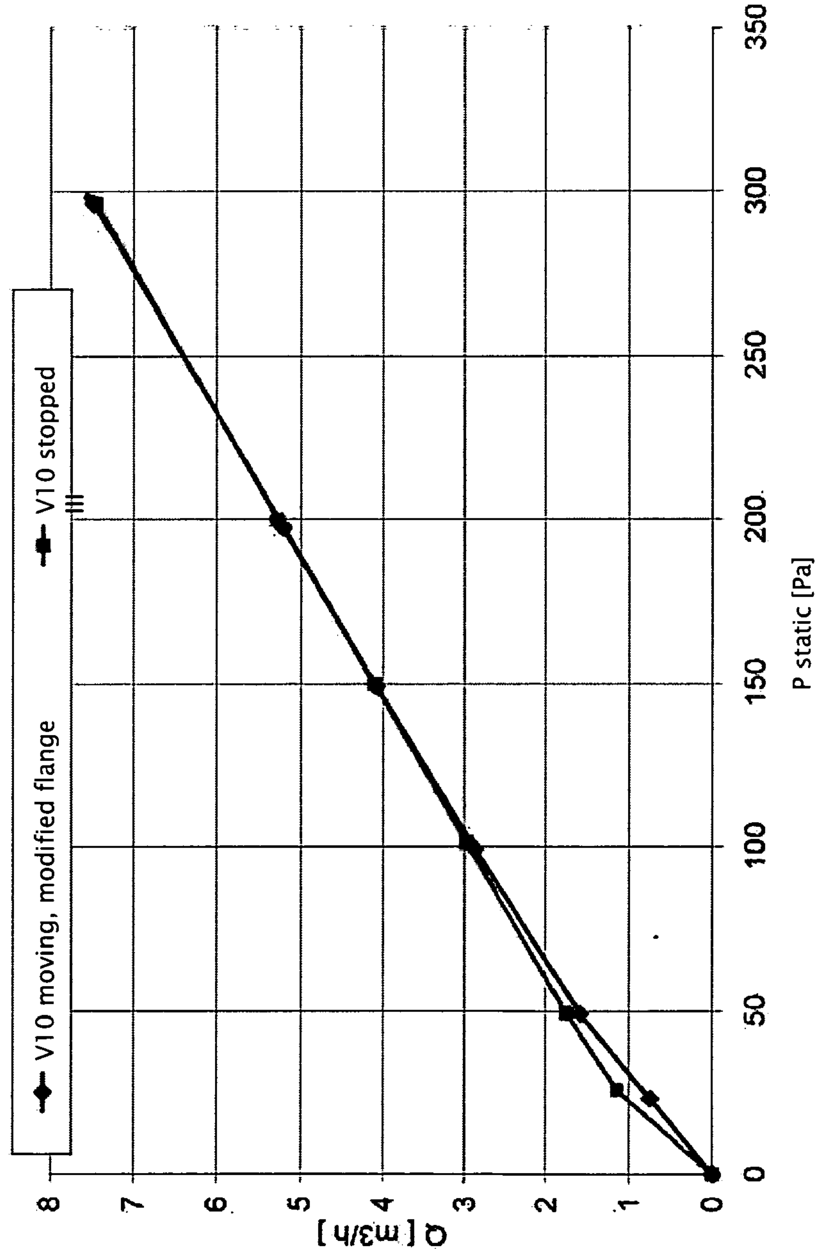
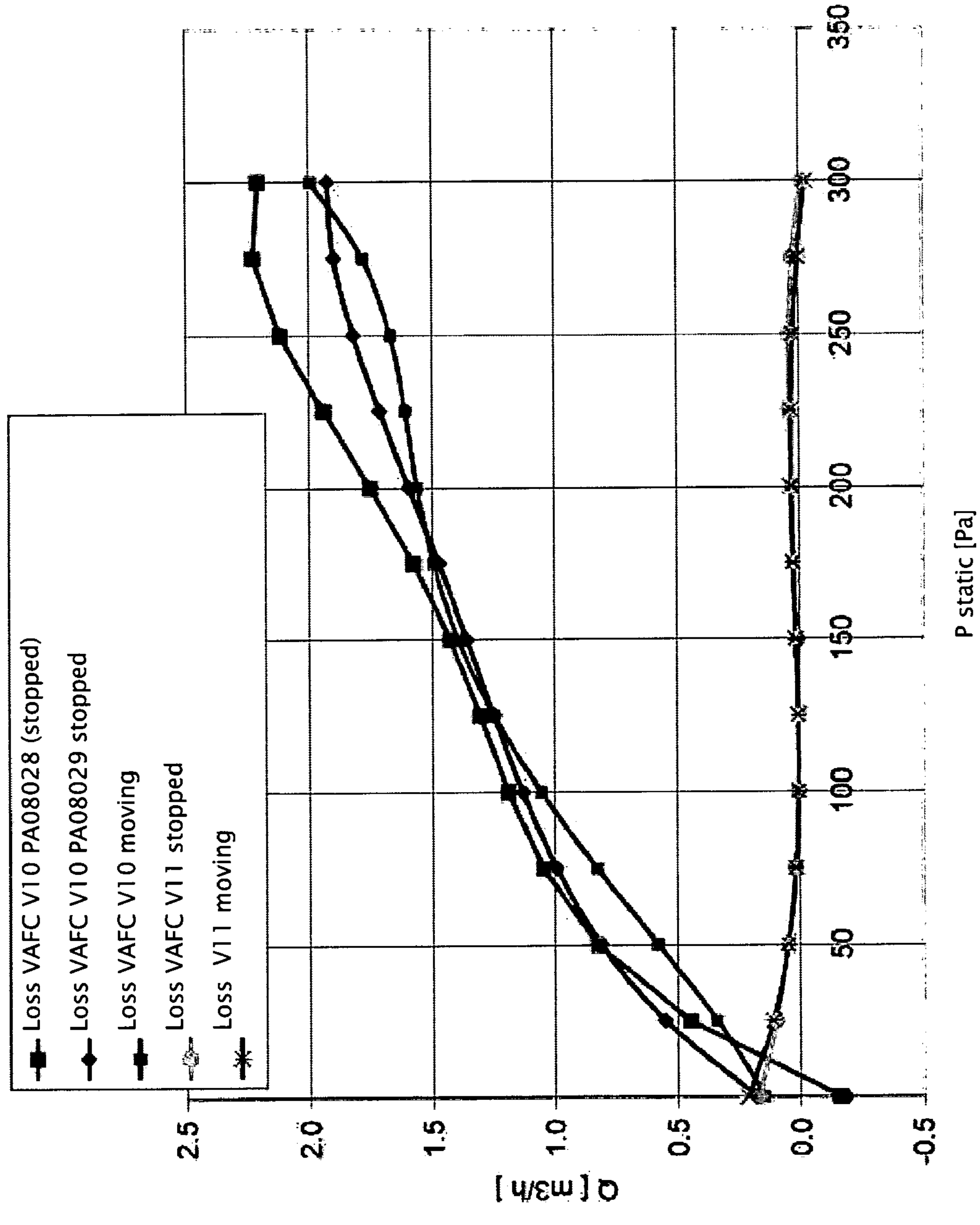


FIG. 8


Loss VAFC V10 PA08028 (stopped)
Loss VAFC V10 PA08029 stopped
Loss VAFC V10 moving
Loss VAFC V11 stopped
Loss V11 moving
Q [m3/h]
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
0
50
100
150
200
250
300
350
P static [Pa]

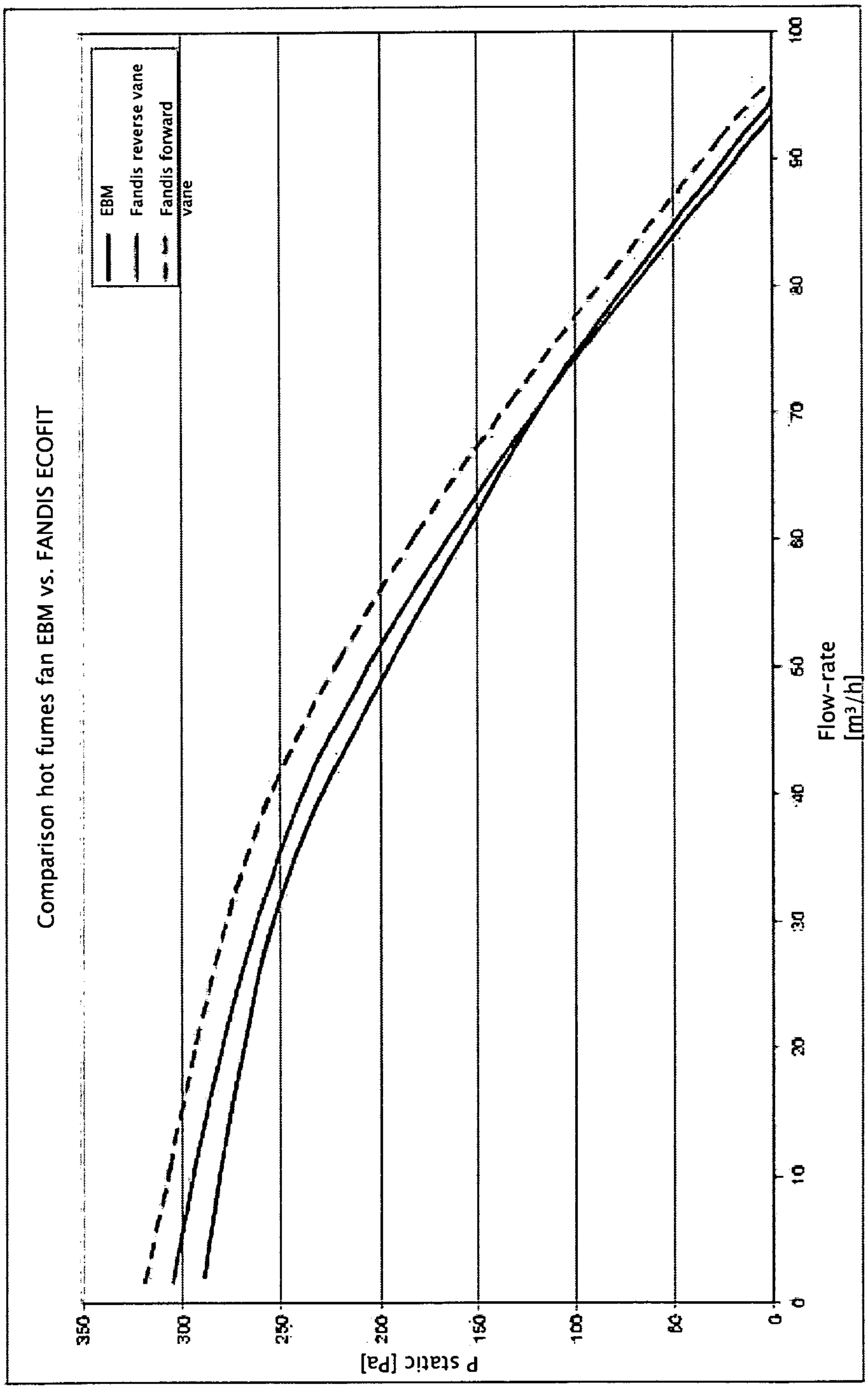

Comparison hot fumes fan EBM vs. FANDIS ECOFIT
EBM
Fandis reverse vane
Fandis forward vane
P static [Pa]
Flow-rate [m^3/h]
0
50
100
150
200
250
300
350
10
20
30
40
50
60
70
80
90
100

FIG. 9

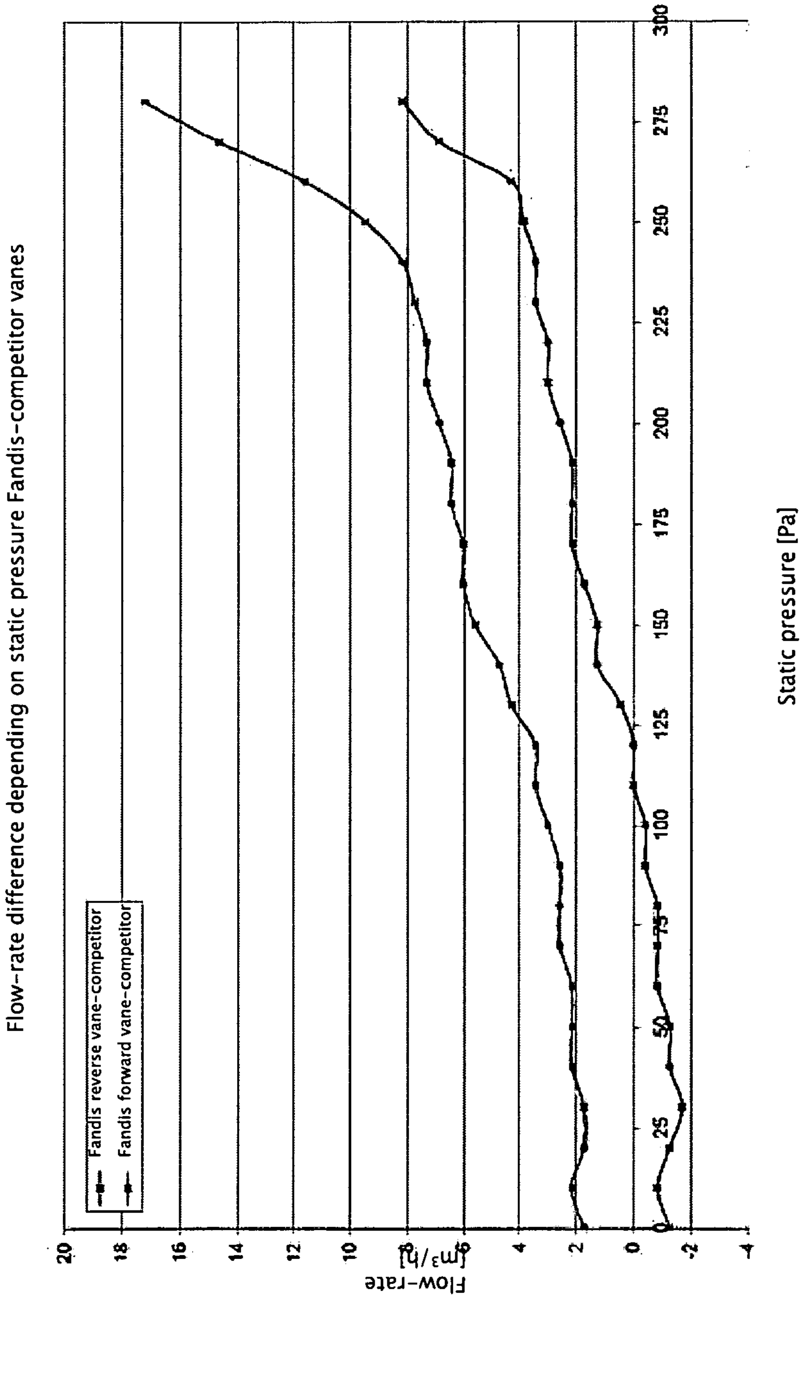

Flow-rate difference depending on static pressure Fandis-competitor vanes
Fandis reverse vane-competitor
Fandis forward vane-competitor
Flow-rate
[m³/h]
Static pressure [Pa]
20
18
16
14
12
10
8
6
4
2
0
-2
-4
0
25
50
75
100
125
150
175
200
225
250
275
300

FIG. 10

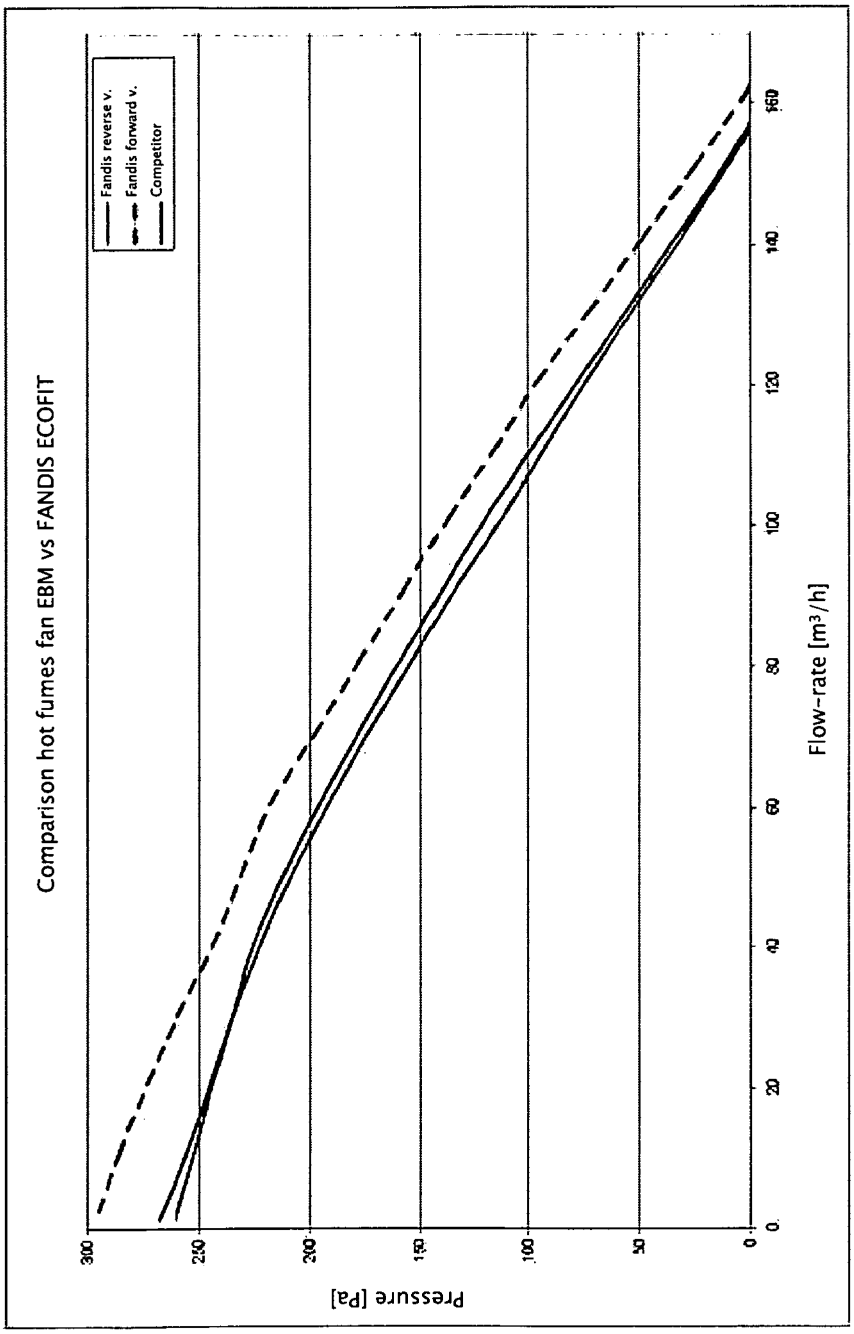

Comparison hot fumes fan EBM vs FANDIS ECOFIT
Fandis reverse v.
Fandis forward v.
Competitor
Pressure [Pa]
300
250
200
150
100
50
0
0
20
40
60
80
100
120
140
160
Flow-rate [m³/h]

FIG. 11

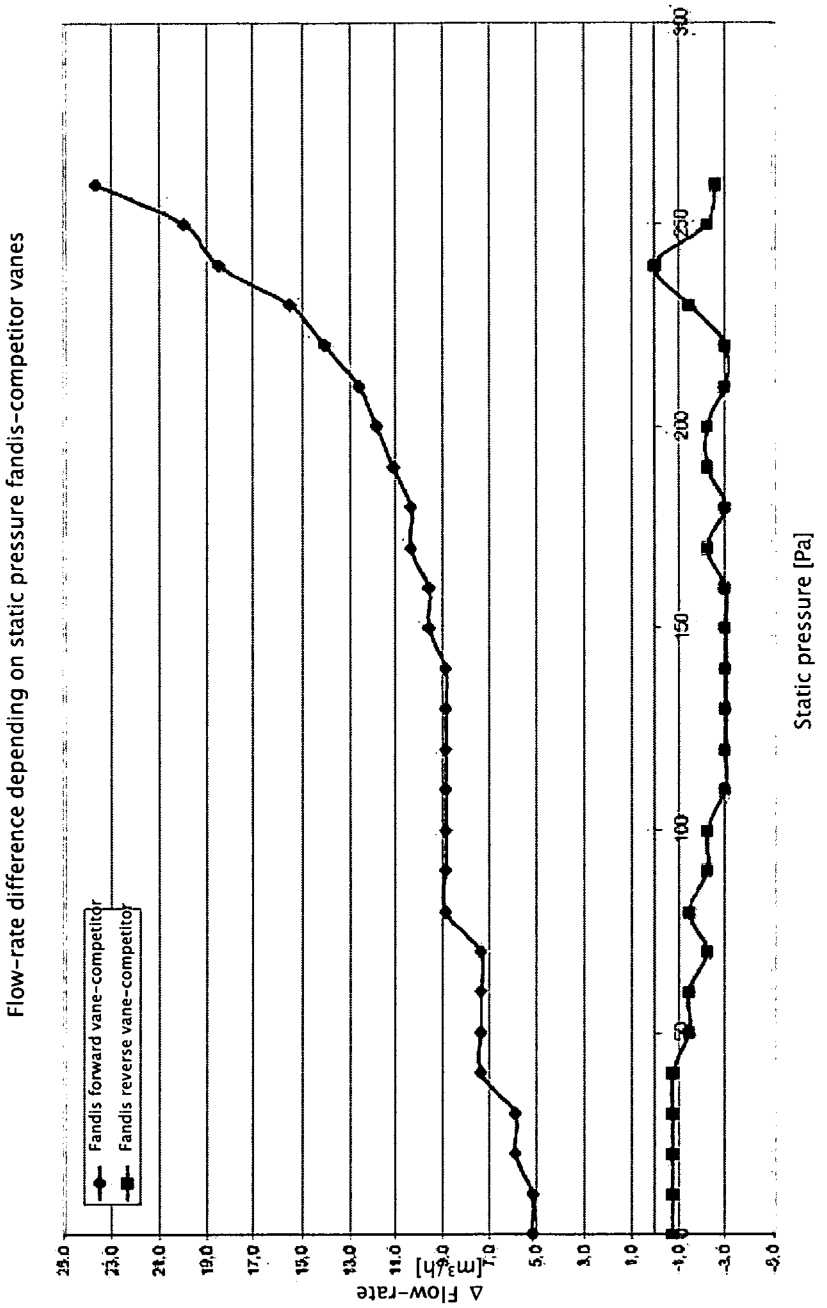

Flow-rate difference depending on static pressure fandis-competitor vanes
Fandis forward vane-competitor
Fandis reverse vane-competitor
Δ Flow-rate [m3/h]
Static pressure [Pa]
25,0
23,0
21,0
19,0
17,0
15,0
13,0
11,0
9,0
7,0
5,0
3,0
1,0
-1,0
-3,0
-5,0
0
50
100
150
200
250
300

FIG. 12

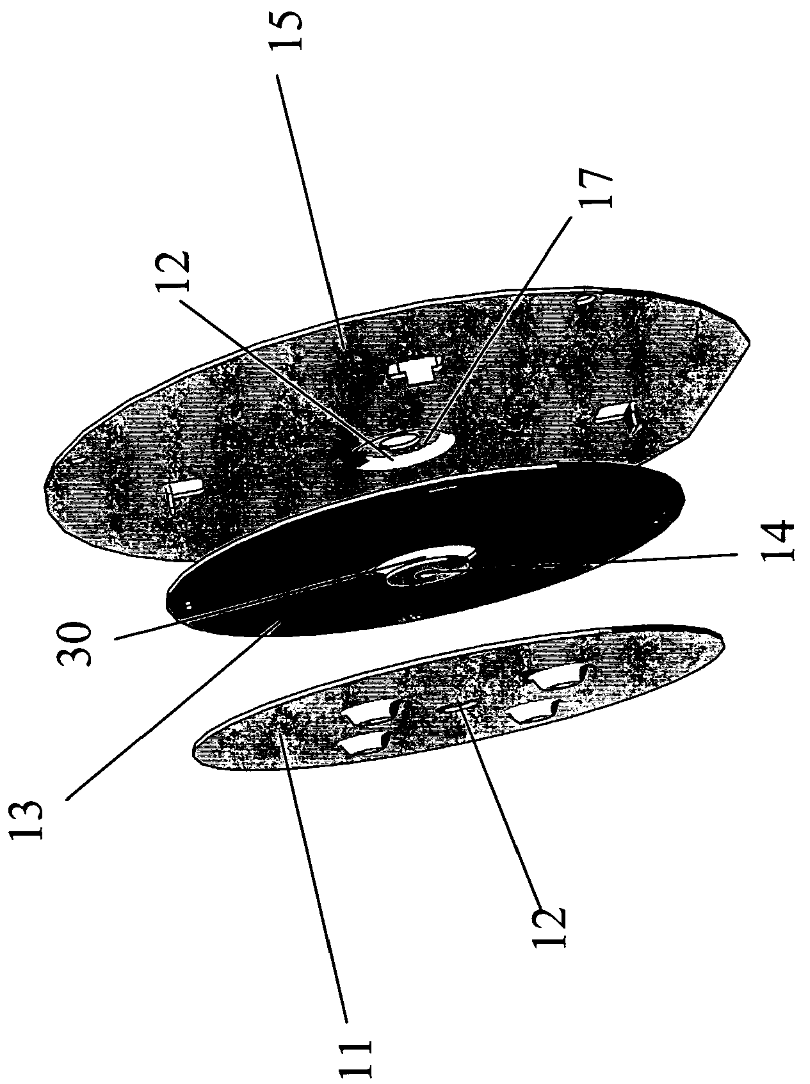


FIG. 4A

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EUROPEAN SEARCH REPORT

Application Number
EP 09 01 0912

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	WO 00/57064 A1 (TURK ELEKTRIK ENDUSTRISI AS [TR]; EGIN RIDVAN [TR]; BAHADIR AYDIN [TR]) 28 September 2000 (2000-09-28) * page 2, line 19 - page 3, line 17; figures 3,4 *	1,4	INV. F04D25/16 F04D29/26 F04D29/28 F04D29/58 F04D29/62 F04D25/06
A	US 2005/103339 A1 (DALY GEOFFREY D [AU] ET AL) 19 May 2005 (2005-05-19) * paragraph [0050] - paragraph [0052]; figures 1,2 * * paragraph [0089]; figure 10 * * paragraph [0103]; figure 13a *	1,4-5	
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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	14 October 2009	Di Giorgio, F

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2

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